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As defense budgets continue to shrink, cost-effective methods for the accurate and timely acquisition of aerodynamic data must be developed. Traditionally, wind tunnels have fulfilled this role at both the conceptual and developmental stages, as well as, throughout the service life of an aircraft. However, although wind tunnels are a trusted and valuable data source that provide consistent, repeatable data upon which to construct aerodynamic models, they also have inherent limitations such as blockage effects, wall and sting interference, and flow variations. Because of these constraints and due to the elevated angles-of-attack and sideslip that modern fighter aircraft are capable of, wind tunnels can be limited in their ability to cover an entire flight envelope. Another problem with the construction of aerodynamic models using wind tunnel data is the discontinuities that arise from the fundamental requirement for multiple -- and usually dissimilar -- data sources to construct a full-envelope model (rotary balance data combined with low-speed forced oscillation data; low-speed static data appended with supersonic data; and so on). A final problem that plagues wind tunnel testing, a problem that is likely to worsen given the recent closure of some facilities (e.g., NASA Langley's 30x60 tunnel), is the often limited availability of the resource; one wind tunnel facility can typically support many different platforms and programs, both civilian and military, and all of these must compete with one another for facility time.

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SIMULATION SUPPORT OF A 17.5% SCALE F/A-18E/F REMOTELY PILOTED VEHICLE

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Abstract

As defense budgets continue to shrink, cost-effective methods for the accurate and timely acquisition of aerodynamic data must be developed. Traditionally, wind tunnels have fulfilled this role at both the conceptual and developmental stages, as well as throughout the service life of an aircraft. However, although wind tunnels are a trusted and valuable data source that provide consistent, repeatable data upon which to construct aerodynamic models, they also have inherent limitations such as blockage effects, wall and sting interference, and flow variations. Because of these constraints and due to the elevated angles-of-attack and sideslip that modern fighter aircraft are capable of, wind tunnels can be limited in their ability to cover an entire flight envelope. Another problem with the construction of aerodynamic models using wind tunnel data is the discontinuities that arise from the fundamental requirement for multiple — and usually dissimilar — data sources to construct a full-envelope model (rotary balance data combined with low-speed forced oscillation data; low-speed static data appended with supersonic data; and so on). A final problem that plagues wind tunnel testing, a problem that is likely to worsen given the recent closure of some facilities (e.g., NASA Langley's 30x60 tunnel), is the often limited availability of the resource; one wind tunnel facility can typically support many different platforms and programs, both civilian and military, and all of these must compete with one another for facility time.

One innovative solution for augmenting aerodynamic data collected from wind tunnels is the use of sub-scale, unpowered, free-flight models. Although useful, scaled free-flight models have historically been unable to generate data on the scale associated with wind tunnels due to technical and/or logistical limitations. Recent advances in sub-scale propulsion coupled with a realization that, given an adequate data collection system, it is possible to collect meaningful aerodynamic data from a free-flight model *without* it being inertially-scaled. Thus, it became possible to construct an RPV, as inertially-scaled as possible given the newly-available propulsion system, and use it to collect useful aerodynamic data that could, in turn, be employed in simulation data base validation and improvement.

Due to the relatively high risk associated with such a venture, both technically as well as literally, the use of high-fidelity simulation was mandated. While not the first attempt to use a six degree-of-freedom simulation to support an RPV flight program, this marks the first successful use simulation for both related engineering analysis and flight training purposes.

This paper will summarize the simulation effort conducted by the Naval Air Warfare Center Aircraft Division (NAWC AD) as it relates to the first flight of a 17.5% scale F/A-18E/F RPV built jointly by NAWC AD, North Carolina State University (NCSU), Bihrle Applied Research, Inc. (BAR), and SWB Turbines, Inc. (SWB).